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The Wolffish Fishery at West Greenland

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Introduction

Three species of wolffish occur off West Greenland: spotted wolffish, *Anarhichas minor*, Atlantic (or striped) wolffish, *A. lupus*, and northern wolffish, *A. denticulatus*. Only the spotted and striped wolffishes are of commercial interest, the flesh of the northern wolffish being too watery. Although the spotted and striped wolffishes are easily distinguished from each other, the fishing industry and reported statistics of catches make no distinction between them. Although some observations have been made on species composition of research vessel catches, detailed biological assessment of the stocks is not possible without separate statistical data for the two species. Also, age determination of wolffish is difficult, and no suitable age-length keys are available for estimating the age composition of wolffish catches in West Greenland waters. In the absence of suitable data to undertake a detailed assessment of the stocks, scientific advice for management of the species will, for the time being, have to be based on rather general historical information about the fishery, including estimated catch statistics and some biological considerations.

Fishery Trends

The annual catches of wolffish off West Greenland since 1945 are shown in Fig. 1 and their distribution by country and division are given in Table 1. Catch statistics for 1945-59 are from the ICES Bulletin Statistique and Beretningér vedr. Grønland and for 1960-78 from the ICNAF Statistical Bulletin. Provisional catches are indicated for 1979. The wolffish catches for Federal Republic of Germany in 1977-79 are estimated as 2% of its total reported catches in these years, as the reported species composition of the nominal catch in each of these years is regarded as dubious (Horsted, MS 1980).

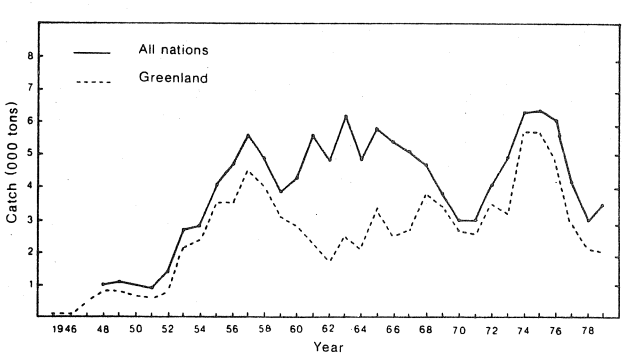

Fig. 1. Nominal catches (metric tons) of wolffish in Subarea 1, 1945-79.

Except for a period in the 1960's, most of the wolffish caught in Subarea 1 were landed in Greenland (Fig. 1). After the rapid development of the fishery in the 1950's, the annual catch fluctuated between 4,000 and 6,000 tons during 1955-68, declined to about 3,000 tons in 1970-71, increased to more than 6,000 tons during 1974-76, and subsequently declined to about half of the maximum level. Most of the wolffish landed by Greenland fishermen were taken in the northern divisions whereas the catches by other countries were mainly from the southern divisions of the subarea (Table 1).

The Greenland fishery

The local fishery for wolffish (almost entirely spotted wolffish), mainly with longlines, began in 1938 and was originally based on the production of skins for export, the meat being used for human consumption and as food for sledge dogs. No production of skins took place during World War II, but it was resumed in 1945 and continued until 1951. Production peaked in 1948 with more than 100,000 skins being processed, corresponding to about 800 tons (whole fresh fish) which were taken mainly in Div. 1A and 1B.

The production of frozen fillets began in 1951 and developed to become an important industry centered initially in the Sukkertoppen area (Div. 1C) but gradually expanding to other areas, especially in Div. 1A and 1B. This fishery was also carried out with longlines directed mainly to spotted wolffish. The catch peaked at 4,500 tons in 1957, decreased to a minimum of 1,700 tons in 1962, but remained above 2,000 tons during 1963-75 with a peak at 3,800 tons in

TABLE 1. Nominal catches (metric tons) of wolffish in Subarea 1 by country, and percentage distribution of Greenland and 'others' catches by division. (Figures in parentheses are estimates; + indicates less than 1%.)

	Nominal catches by country[a]								Total	Percent of Greenland catch							Percent of 'Others' catch						
Year	GRL	FRG	FAR	GDR	ICE	NOR	USSR	UK	catch	1A	1B	1C	1D	1E	1F	NK	1A	1B	1C	1D	1E	1F	NK
1945	60	—	—	—	—	—	—	—	60														
1946	50	—	—	—	—	—	—	+	50	65	32	1	2	+	—	—							
1947	500	—	—	—	—	—	—	+	500	75	18	—	—	3	4	—							
1948	800	—	—	—	—	—	—	155	955	72	15	2	1	3	8	—							
1949	780	—	—	—	6	—	—	318	1,104	81	12	2	—	2	3	—							
1950	730	—	—	—	—	—	—	12	742	85	10	1	2	2	2	—							
1951	620	—	—	—	46	—	—	220	886	70	24	+	2	1	3	—							
1952	760	12	—	—	66	—	—	550	1,388	7	50	43	—	—	—	—							
1953	2,100	21	—	—	103	—	—	510	2,734	—	6	94	—	—	—	—							
1954	2,434	17	—	—	—	75	—	278	2,804	1	—	99	—	—	—	—							
1955	3,520	446	—	—	—	—	53	20	4,039	1	4	93	2	—	+	—							
1956	3,500	1,090	—	—	79	—	—	22	4,691	9	11	80	1	—	—	—							
1957	4,500	721	—	—	235	24	—	122	5,602	13	12	74	1	—	—	—							
1958	4,000	479	—	—	50	20	—	330	4,879	16	22	62	—	—	—	—							
1959	3,100	469	—	—	64	—	—	275	3,908	12	26	62	+	—	+	—							
1960	2,822	813	—	—	—	—	—	652	4,287	11	39	50	—	+	+	—	—	4	6	37	23	30	—
1961	2,302	2,616	39	—	247	—	—	419	5,623	16	31	53	—	+	+	—	+	5	18	35	20	20	2
1962	1,712	2,545	—	—	164	—	—	520	4,941	14	31	53	—	—	2	—	+	10	21	25	26	17	—
1963	2,466	2,806	5	—	107	—	—	774	6,158	21	22	51	4	—	2	—	—	9	18	30	25	18	+
1964	2,085	1,588	—	—	71	25	—	1,109	4,878	23	29	34	10	+	4	—	+	8	16	24	29	23	+
1965	3,274	1,854	—	—	80	29	7	535	5,779	15	26	47	7	1	4	—	1	12	21	29	16	20	—
1966	2,478	1,541	—	339	96	40	—	897	5,391	12	23	51	5	—	8	—	—	15	9	27	23	25	+
1967	2,700	1,777	—	88	—	10	—	558	5,133	15	39	36	5	1	4	—	2	8	14	41	18	16	+
1968	3,812	582	—	97	—	120	3	65	4,679	15	37	37	4	1	6	—	—	—	27	26	13	20	14
1969	3,356	199	—	—	—	204	—	—	3,759	19	31	42	5	1	1	+	—	—	3	13	13	21	50
1970	2,702	208	—	—	—	—	—	83	2,993	24	36	28	1	1	1	8	—	—	1	19	33	47	—
1971	2,613	132	152	—	—	36	—	99	3,032	20	32	28	4	1	1	14	—	—	1	20	9	34	36
1972	3,464	555	57	—	—	—	—	71	4,147	15	26	20	14	+	+	25	—	—	8	30	50	12	—
1973	4,186	489	13	—	—	108	89	16	4,901	18	24	25	20	9	3	—	—	—	6	37	41	13	3
1974	5,747	136	—	—	—	210	80	117	6,290	9	21	23	34	11	2	—	—	1	20	35	36	9	—
1975	5,687	400	—	—	—	177	102	12	6,378	9	24	25	35	6	1	—	—	1	30	13	30	27	—
1976	4,923	659	—	—	—	183	321	19	6,105	9	13	36	29	12	1	—	—	11	18	26	22	23	—
1977	3,004	(1,000)	—	—	—	50	56	—	4,210	15	21	33	19	9	3	—							
1978	2,154	(800)	—	—	—	16	—	—	2,970	21	35	35	6	3	+	—							
1979	2,129	(1,400)	—	—	—	—	—	—	3,529	15	45	32	3	3	2	—							

[a] GRL = Greenland, FRG = Federal Republic of Germany, FAR = Faroe Islands, GDR = German Democratic Republic, ICE = Iceland, NOR = Norway, USSR = Union of Soviet Socialist Republics, and UK = United Kingdom.

1968 (Table 1). Since 1975 the longline catches declined to a level below 2,000 tons annually (Table 2). These longline catches were taken mainly in coastal waters.

The catch of wolffish in the offshore trawl fishery increased from very small quantities (as by-catches) in 1972 to a peak level of about 3,200 tons in 1974-76. The increased interest in wolffish was a consequence of the declining cod fishery, whereby the trawlers had to search for other resources with wolffish being one of the target species. However, with the development of the more economic shrimp fishery on the offshore grounds in recent years, Greenland trawlers now switch between cod and shrimp as target species, and the landings of wolffish are virtually by-catches in fisheries directed to those species. Consequently, the Greenland catches of wolffish are now at a low level,

TABLE 2. Greenland trawl and longline catches of wolffish in Subarea 1, 1974-79.

Gear	1974	1975	1976	1977	1978	1979
Trawl	3,273	3,192	3,297	1,197	323	197
Longline	2,474	2,495	1,626	1,807	1,831	1,932
Total	5,747	5,687	4,923	3,004	2,154	2,129

due mostly to the steep decline in trawl catches since 1976 but also to the decline in longline catches in recent years (Table 2). In 1979, more than 90% of the wolffish landed at fishery plants of the Royal Greenland Trade Department were caught mainly by longlines from June to December.

The fishery of other countries

From 1928 to the beginning of World War II, small catches of wolffish in Greenland waters were landed by British fishing vessels. After 1945, wolffish catches were reported by vessels of several countries, especially by Federal Republic of Germany trawlers (Table 1). Catches were highest during 1961-67 when about 3,000 tons were landed annually. The decline in the late 1960's was due to a significant reduction in fishing effort, as fewer vessels fished in West Greenland waters because of the failing cod fishery. The trawl catches of wolffish were mainly in Div. 1D to 1F (Table 1). Those from the shallow parts of the banks seem to be dominated by striped wolffish, whereas spotted wolffish may constitute a greater part of the by-catches when fishing is carried out at greater depths. Annual catches by Federal Republic of Germany trawlers have increased in recent years to about 1,000 tons or more during 1977-79.

TABLE 3. Some observations on species composition of wolffish catches in Subarea 1. (LL = longline, OT = otter trawl).

Gear	Div.	Year	Depth (m)	% *A. minor* No.	% *A. minor* Wt.	% *A. lupus* No.	% *A. lupus* Wt.	No. observed
LL (Commercial)	1A	1957	25-300	99	99	1	1	6,126
	1B	1957	30-400	98	99	2	1	4,368
LL (Research)	1A	1960	250-600	100	100	—	—	83
	1B	1956	70-260	69	93	31	7	810
	1D	1956	20-300	87	97	13	3	586
OT (Commercial)	1C	1976	70-90	1	1	99	99	2,000
	1D	1980	300-500	18	42	82	58	802
OT (Research)[a]	1A-F	1955, 1963	100-500	20	40	80	60	?

[a] Data from Beese and Kändler (1969).

Occurrence and Biology

A. minor and *A. denticulatus* are known to be common in all parts of the West Greenland area (Div. 1A to 1F), but *A. lupus* tends to have a more southerly distribution occurring rarely in Div. 1A. Observations on the species composition of wolffish in longline catches (Table 3) indicate that *A. minor* was dominant in inshore waters. *A. lupus*, which is rather common at shallow depths, was not represented in longline catches deeper than 200 m and was taken only in small numbers with the shrimp trawl (Smidt, 1969, p. 143-144). In offshore trawl catches by research vessels of Federal Republic of Germany in 1955 and 1963 (Beese and Kändler, 1969) and by Greenland commercial trawlers in 1976 and 1980, *A. lupus* was dominant on the shallow fishing banks off southern West Greenland (Div. 1C-1F) where it constituted 80-100% of the wolffish catches (Table 3).

Trawling experiments at different depths (Beese and Kändler, 1969) showed that *A. lupus* is most frequent at depths less than 100 m, whereas the other two species generally have a wider depth range (Table 4). These authors also indicated that *A. lupus* has a wider temperature tolerance from -1° to 10°C, and, according to its more southerly geographic distribution, it has a higher optimum (1° to 4°C) than the other two species. *A. minor* has a range of tolerance from -1° to 7°C with an optimum from 0° to 2°C, and *A. denticulatus* has nearly the same temperature tolerance as *A. minor* with its optimum from 1° to 2°C.

Little is known about the propagation of the three wolffish species in Greenland waters. Observations in other areas indicate that all three species deposit their eggs in lumps at considerable depths on the bottom. The pelagic larvae are found during the summer in large numbers over the slopes of the fishing banks and in the open sea, their occurrence in inshore waters being rare. Hansen (1968) reported on the occurrence and distribution of wolffish larvae off West Greenland based on data from the NORWESTLANT surveys in 1963, and noted the concentration of larvae, especially *A. minor*, off Sukkertoppen (Div. 1C), where an important fishery for *A. minor* was carried out in the winter months during several years. It is possible that the larvae are carried by the West Greenland Current to nursery grounds in northern waters where they grow and subsequently migrate to more southerly spawning grounds. Observations from fishing experiments

TABLE 4. Distribution by depth of three wolffish species in research otter-trawl catches off West and East Greenland (after Beese and Kändler, 1969).

Depth (m)	Average number per hour trawling *A. lupus*	*A. minor*	*A. denticulatus*
<100	29.7	3.2	8.2
100-200	6.5	3.8	4.5
200-300	12.1	1.8	1.6
300-400	7.8	1.7	1.8
400-500	0.8	1.4	1.5
500-600	—	—	2.0
600-700	—	—	—
700-800	—	—	1.5
>800	—	—	1.0

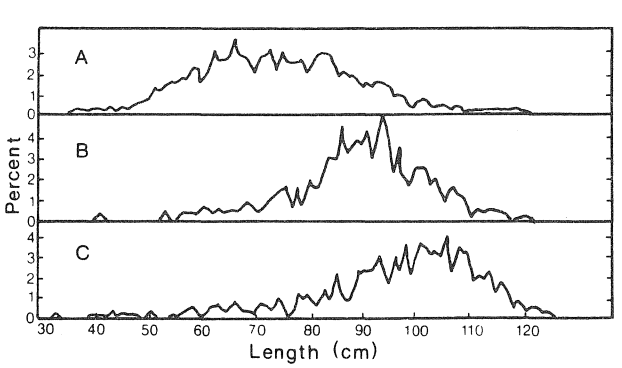

Fig. 2. Length frequencies of spotted wolffish, *A. minor*, from three regions of West Greenland: A, Div. 1A north (72°08'N); B, Div. 1A south (69°28'N); C, Div. 1B-1C. (From Hansen, 1959).

TABLE 5. Average length-at-age of spotted and striped wolffish in subarctic waters (after Beese and Kändler, 1969).

Age (yr)	*A. minor* No. of spec.	*A. minor* Length (cm)	*A. lupus* No. of spec.	*A. lupus* Length (cm)
5	10	34.7	13	24.2
6	7	41.3	12	28.6
7	11	51.0	24	36.7
8	13	59.8	21	42.2
9	13	66.8	22	45.5
10	11	70.9	14	48.6
11	9	81.2	6	55.7
12	15	86.3	14	56.9
13	18	90.4	7	62.9
14	13	97.6	8	67.1
15	5	101.0	4	70.0
16	4	107.5	4	71.5
17	1	108.0	2	77.0

indicate that *A. minor* of small and medium size are common in catches in northern West Greenland, whereas larger sizes are more common in southern areas (Fig. 2). However, tagging experiments indicate that this species is rather stationary.

According to Beese and Kändler (1969) and Østvedt (1963), females of striped and spotted wolffish mature about 1 year earlier and at a smaller size than males. The females of *A. lupus* mature at lengths of 31–46 cm and the males at 42–69 cm, whereas the females of *A. minor* mature at 48–62 cm and the males at 53–71 cm.

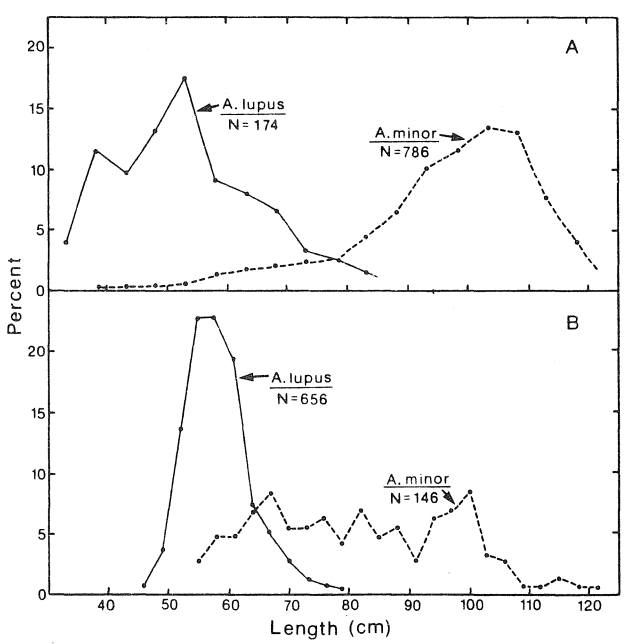

Fig. 3. Length frequencies of striped wolffish, *A. lupus*, and spotted wolffish, *A. minor*: A, from longline catches in Div. 1B–1D by 5-cm length groups (from Hansen, 1959); B, from trawl catches in Div. 1D by 3-cm length groups, March 1980.

Age readings have been made from otoliths of all three species (Beese and Kändler, 1969) and from vertebrae of *A. minor* (Østvedt, 1963). Average length-at-age values for *A. lupus* and *A. minor* in subarctic areas (Greenland waters and Barents Sea) indicate that striped wolffish grow much slower than spotted wolffish (Table 5), thus accounting for the great difference in size composition of the two species in the catches (Fig. 3). When recruited to the fishery at a length of about 50 cm, *A. lupus* is about 10 years old and *A. minor* is about 7 years old. The length-weight relationships for both species (Fig. 4), based on samples from trawl catches in Div. 1D, are very similar over the comparable length ranges.

General Conclusions

The exploitation of wolffish at West Greenland involves two different fisheries on two different species, an inshore longline fishery mainly for spotted wolffish and an international trawl fishery for cod and redfish in which striped wolffish occurs as by-catch. On some occasions, Greenland trawlers fished directly for wolffish but only when catches of the major species were extremely low or restricted. The two species of wolffish must therefore be studied separately for assessment purposes.

Originally, the inshore longline fishery for spotted wolffish was mainly a directed fishery, but later by-

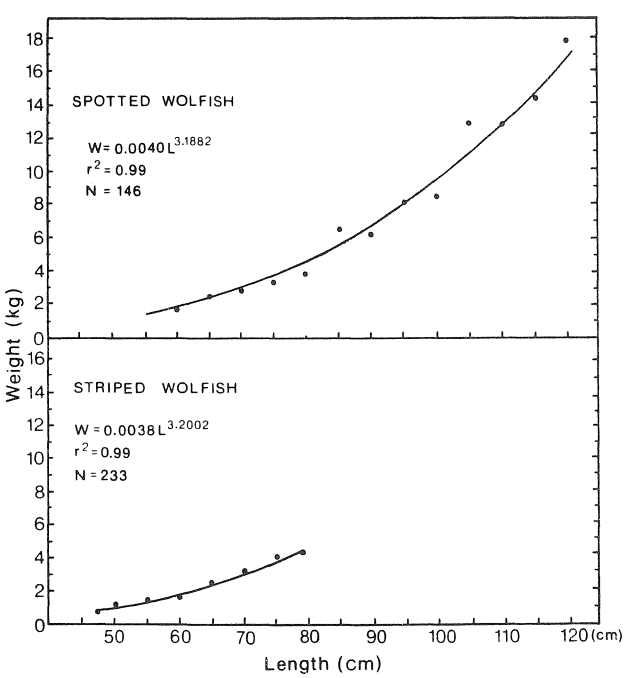

Fig. 4. Length-weight relationships for spotted wolffish, *A. minor*, and striped wolffish, *A. lupus*, based on data from trawl catches in Div. 1D, March 1980.

catches of wolffish in longline fishing for other species consittuted a significant part of the landings. The fishery culminated in the mid-1950's with nominal catches of about 4,000 tons annually and decreased thereafter due possibly to overexploitation. Catches fluctuated around 3,000 tons annually in the 1960's and were at a level of about 2,000 tons in the 1970's with a slightly declining trend due to reduced fishing effort.

The international trawl fishery yielded catches of striped wolffish around 3,000 tons annually in the 1960's, after which catches declined due to decreased effort. In the middle of the 1970's, catches, mainly by Greenland trawlers, reached a second peak of about 4,000 tons annually, which was again followed by a decline.

An assessment of the wolffish stocks in Subarea 1 is not possible until better biological data become available and the fishery statistics are separated by species. The historical fishery statistics indicate that it is reasonable to estimate a sustainable yield of 2,000–3,000 tons annually for spotted wolffish and about 3,000 tons annually for striped wolffish. Since the inshore longline fishery has normally been moderate in size, there seems to be no need at present for a regulation of that fishery, but it may be advisable to regulate a trawl fishery should such a fishery develop.

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